IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of

Krister HANSSON et al.

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For: PROCESS FOR ACHIEVING DECOR ON SURFACE ELEMENTS

DECLARATION OF INGVAR SYLEGARD UNDER 37 CFR § 1.131

Commissioner for Patents
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1. I, Ingvar Sylegard, am a patent attorney in Sweden.

2. I am familiar with the subject matter of the present application, as well as of the most recent Office Action and the references cited therein.

3. I drafted Swedish priority application i.e. SE 9904781-3 (hereinafter SE '781). A verified English-language translation of SE '781 is provided as an attachment hereto;

4. The subject matter of the SE '781 was transmitted to me by the inventors of the present application prior to December 14, 1999.

5. I was working on preparing the Swedish application which became SE '781 for filing in the Swedish Patent Office in the period between December 14, 1999 and the date of the filing of SE '781, or December 23, 1999.

4. Further, declarant sayeth not.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these

statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful statements may jeopardize the validity of the application or any patent issuing thereon.

May 28, 2004
Date

Ingvar Sylegard

Process for the manufacturing of surface elements.

The present invention relates to a process for the manufacturing of surface elements with a decorative upper surface of which the decorative elements have a significantly improved matching in transitions between surface elements.

Products clad with thermosetting laminate is common nowadays. They are foremost used where the need for abrasion resistance is high, but also where resistance towards various chemicals and moisture is required. As an example of such products can be mentioned floors, floor skirting, work tops, table tops and wall panels.

The thermosetting laminate most often consists of a number of base sheets with a decorative sheet placed closest to the surface. The decorative sheet can be provided with a desired decor. Common decor usually represents different kinds of wood or a mineral such as marble or granite.

Block pattern is a common pattern. The floor elements, which normally are board shaped, are here provided with a decor that simulates two or more longitudinal rows of blocks of for example wood.

Traditional manufacturing of laminate floor comprises a number of steps, which will result in a matching tolerance regarding decor between random floor elements of up to ±5mm, which is to be regarded to great. The steps normally comprised in a manufacturing process for laminate floors is; printing a decor on a paper of α-cellulose, impregnating the decor paper with melamine formaldehyde resin, pressing and curing of the decor paper together with a number of papers with a supporting purpose, applying the decorative laminate on a carrier and finally sawing and milling the carrier to the desired format. All these steps will cause a change in format of the decor paper. It will therefore be impossible to achieve a desired matching of decor without a great wastage.

It has, through the present invention, been made possible to overcome the insufficiencies above and it has been made possible to manufacture a surface element with a decorative surface where the decorative pattern is matching between different surface elements. The invention relates to a process for the manufacturing of floor, wall and ceiling elements. The surface elements includes an upper decorative layer, edges intended for joining, a lower side and a supporting core. The invention is characterised in that;

i) A supporting core with a desired format is manufactured and provided with an upper side and a lower side.

ii) The upper side of the supporting core is then provided with decor by, for example printing. The decor is oriented after a predetermined fixing point on the supporting core.

iii) The upper side of the supporting core is then provided with a protecting, at least partially translucent, wear layer by for example curtain coating, spray coating, immersion coating, roller coating or by being provided with one or more sheets of α-cellulose.

The decor is suitably obtained by digitisation of an actual archetype or by partly or completely being created in a digital media. The digitised decor is stored in a digital form in order to be utilised, together with possible guiding programs, as a guiding means and basic data for the printing of the decor. It is also possible to utilise at least part of the digitised decor together with support programs to guide further steps of the process as identification marking, packing, lacquering, storing and delivery logistics, surface structuring and the like.

It is advantageous to manufacture the core in the desired end user format and to provide it with edges intended for joining before the application of decor and wear layer, since the amount of waste will be radically reduced. The measurement tolerances in the decor will also be further improved.

The supporting core is mainly constituted of wood particles or wood fibre, but it is also possible to manufacture the supporting core of a material that at least partly is constituted of a polymer such as, for example, polyurethane or a polyolefine such as polyethylene, polypropylene or polybutene. A polymer based core may be manufactured by being press moulded or injection moulded and can be given its shape by plastic machining and will hereby not require any abrasive machining. A polymer based core suitably includes a filler, which besides reducing costs also can be used for modifying the mechanical properties of the core. Such fillers may be in the form of particle or fibre and may be organic or inorganic. As examples of such filler can, among others, be mentioned; wood, straw, starch, glass, lime, stone dust and sand. The mechanical properties that may be modified is for example; thermal coefficient of expansion, ductility, density, fire resistance, moisture absorption capability, sound conductivity dampening, thermal conductivity, flexural and shearing strength as well as softening temperature.

The upper side of the core, i.e. the surface intended to be provided with decor, is suitably surface treated before the printing. Such a surface treatment then suitably

includes one or both of the steps; ground coating and grinding. It is also possible to provide the surface with a structure that matches the decor to be applied.

The transparent wear layer is suitably constituted by a UV- or electron beam curing lacquer such as acrylic, epoxy or maleimide lacquer. The wear layer is suitably applied in several steps with intermediate curing, of which the last is a complete curing while the previous are partial. It is hereby possible to achieve even thick layers being plane to a high degree. The wear layer suitably includes hard particles with an average particle size in the range 50nm - 150μm. Larger particles, in the range 10μm - 150μm, preferably 30μm - 150μm, is foremost used for achieving abrasion resistance while the smaller particles in the range 50nm - 30μm, preferably 50nm - 10μm is used for achieving scratch resistance. The smaller particles are hereby used on or very close to the top surface while the larger particles are distributed in the wear layer. The hard particles are preferably constituted by silicon carbide, silicon oxide, α-aluminium oxide or the like. The resistance to abrasion is hereby radically increased. Particles in the range 30μm - 150μm are sprinkled in still wet lacquer so that the particles are, at least mainly, embedded in the finished wear layer. It is suitable to apply the lacquer in several steps with intermediate sprinkling stations were the particles are applied on the surface. The wear layer can hereafter be cured. It is also possible to mix particles in the range below 20μm - 30μm in the lacquer. Such lacquer is suitably used in the top of the wear layer. It is possible to sprinkle the uppermost surface with very small particles in the range 50nm - 1000nm in order to improve the scratch resistance. Also these, so-called nano-particles, can be mixed into the lacquer, which then is applied as a thin layer with a relatively high content of particles. These nano-particles may besides silicon oxide, silicon carbide and α-aluminium oxide also be constituted of diamond.

According to one alternative embodiment of the invention, the translucent wear layer is constituted by one or more sheets of a-cellulose which are impregnated with melamine formaldehyde resin. These sheets are joined with the supporting core by means of heat and pressure whereby the resin cures. The abrasion resistance can, also in this embodiment be improved by including hard particles with an average particle size in the range 50nm - 150μm in the wear layer. Larger particles, in the range 10μm - 150μm, preferably 30μm - 150μm, is foremost used for achieving abrasion resistance while the smaller particles in the range 50nm - 30μm, preferably 50nm - 10μm is used for achieving scratch resistance. The smaller particles are hereby used on or very close to the top surface while the larger particles are distributed in the wear layer. The hard particles are, also here, preferably constituted by silicon

carbide, silicon oxide, α-aluminium oxide, diamond or the like, of which diamond of cost reason only is used for particles smaller than 1μm. The sheets of α-cellulose are thereby pressed together with the surface element in a continuous laminate press with two steel belts. The pressure in the press is hereby suitably 5 - 100 Bar, preferably 20 - 80 Bar. The temperature is suitably 140 - 200°C, preferably 160 - 180°C. A multiple-opening press, in which several surface elements can be pressed simultaneously, is utilised when pressing discontinuously. The pressure is then normally 20 - 150 Bar, preferably 70 - 120 Bar, and the temperature is suitably 120 - 180°C, preferably 140 - 160°C.

The decor on the surface elements is suitably constituted by a number of decor sections with intermediate borders, which borders on at least two opposite sides coincides with intended adjoining surface element

It is also desirable to provide the surface elements with a surface structure which is intended to increase the realism of the decor the surface elements are provided with. This is suitably achieved by positioning at least one surface structured matrix, forming at least one surface structure section on a corresponding décor section or number of décor sections on the decorated surface of the surface element in connection to the application of wear layer. This matrix is pressed towards the wear layer whereby this will receive a surface with structure that enhances the realism of the décor.

When simulating more complex patterns, like wood block chevron pattern or other orientation divergent decors, it is suitable to use at least two structured matrixes which forms one structure section each. The structure section are here independent from each other in a structure point of view. The surface structure sections are intended to at least partly but preferably completely match the corresponding décor sections of the décor. The surface structure sections are accurately positioned on the décor side of the surface element in connection to the application of the wear layer, and is pressed onto this whereby the wear layer is provided with a surface structure where the orientation of the structure corresponds to the different directions in the décor.

One or more matrixes preferably forms the surface of one or more rollers with counter stays rollers. The surface element is then passed between the roller or rollers and counter stay rollers, with the décor side facing the structured rollers. The structured rollers are continuously or discontinuously pressed towards the décor surface of the surface element.

Rollers containing two or more matrixes, is suitably provided with a circumference adapted to the repetition frequency of change of direction in the décor.

It is also possible to have one or more matrixes form the surface of one or more press belts with counter stays. The surface element is then passed between the press belts and the counter stays under continuous or discontinuous pressure between the structured press belts and the counter stays.

It is, according to one alternative procedure, possible to have one or more matrixes form the structure surface of one or more static moulds which momentary is pressed towards the decorative side of the surface element.

Particularly characteristic decor portions such as borderlines between simulated slabs, staves, blocks or the like and also knots, cracks, flaws and grain which is visually simulated in the decor, is stored as data. Said data is thereby suitably used for guiding automated engraving or pressing tools when providing said characteristic decor portions with a suitable surface structure, and that said engraving tool or pressing tool is synchronised via the predetermined fixing point on the surface element.

The process described in the present application, for manufacturing surface elements is very advantageous from a logistic point of view since the number of steps when achieving new decor is radically reduced. It is, according to the present invention possible to use digitally created or stored data for directly printing a decor on a surface element by using, for example, an ink-jet printer. The so-called set up time will thereby be very short, whereby even very special customer requirements may be met at a reasonable cost. It is according to the present invention possible to manufacture, for example, a world map in very large format, stretching over several surface elements without any disrupting deviations, to mainly the same cost as bulk produced surface elements. Since the decor is handled digitally all the way to the point of being applied to the surface of the supporting core, set up times will be practically non-existent while at the same time a high degree of automation will be practicable. It is also possible to automatically provide the surface elements with identification and orientation marking which would make the installation of complex decor, like world maps according to the above, much easier. This has so far been impossible.

Surface elements manufactured as described above are suitably used as a floor covering material where the demands on stability and abrasion resistance is great. It is, according to the present invention, also possible to use the surface elements as wall and ceiling coating. It will however not be necessary to apply thick wear layer coatings in the latter cases as direct abrasion seldom occurs on such surfaces.

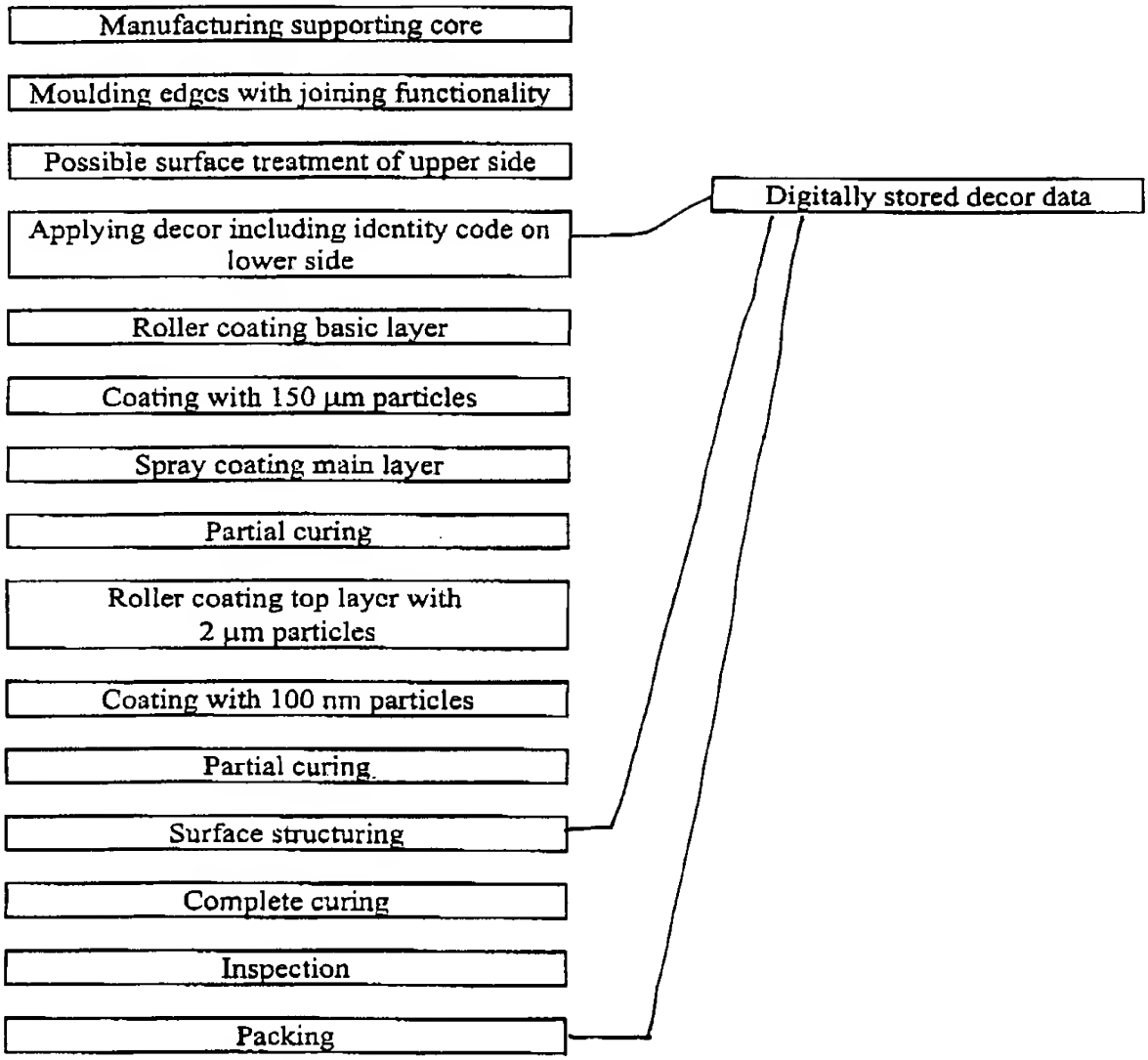
The invention is described further in connection to an enclosed figure and schematic process descriptions showing different embodiments of the invention.

Accordingly, the figure shows parts of a surface element 1 which includes an upper decorative layer 2, edges 3 intended for joining, a lower side 4 and a supporting core 5. The process is initiated by manufacturing a supporting core 5 with a desired user format and edges 3 intended for joining. The supporting core 5 is further provided with an upper side 1' suited for printing and a lower side 4. The upper side 1' of the supporting core 5 is then provided with a decor 2' by printing, utilising an ink-jet printer. The decor 2' is oriented after a predetermined fixing point on the supporting core 5. The upper side 1' of the supporting core 5 is then provided with a protecting translucent wear layer 2'' through curtain coating. The supporting core 5 is constituted by particle board or fibre board. The translucent wear layer 2'' is constituted by a electron beam curing acrylic lacquer which is applied in several steps with intermediate curing, of which the last one is a complete curing while the earlier ones are only partial curing. The wear layer 2'' also includes hard particles of α-aluminium oxide with an average particle size in the range 0,5μm - 150μm.

A surface structured matrix is positioned and pressed towards the decor side of the surface element 1 before the final curing of the acrylic lacquer whereby the surface of the wear layer 2'' receives a surface structure 2''' which enhances the realism of the decor 2'.

It is also possible to utilise two or more surface structured matrixes, each forming a structure section, between which the structure is independent, which will make it possible to simulate the surface structure of, for example, wood block chevron pattern decor.

Process scheme 1



A supporting polymer/filler based core is manufactured in the desired user format and is provided with an upper side, which is levelled by a slight sanding, a lower side and edges intended for joining. The upper side of the supporting core is then provided with a decor which is applied by means of an ink-jet printer. The decor is oriented after a predetermined fixing point in the form of a corner of the supporting core. The basis for the decor is stored as digital data. A basic layer of UV curing acrylic lacquer is then applied by means of a roller coater. Particles with an average particle size in the range 150µm is then sprinkled onto the still wet basic layer, whereupon the main layer of UV-curing acrylic lacquer is applied by means of spray

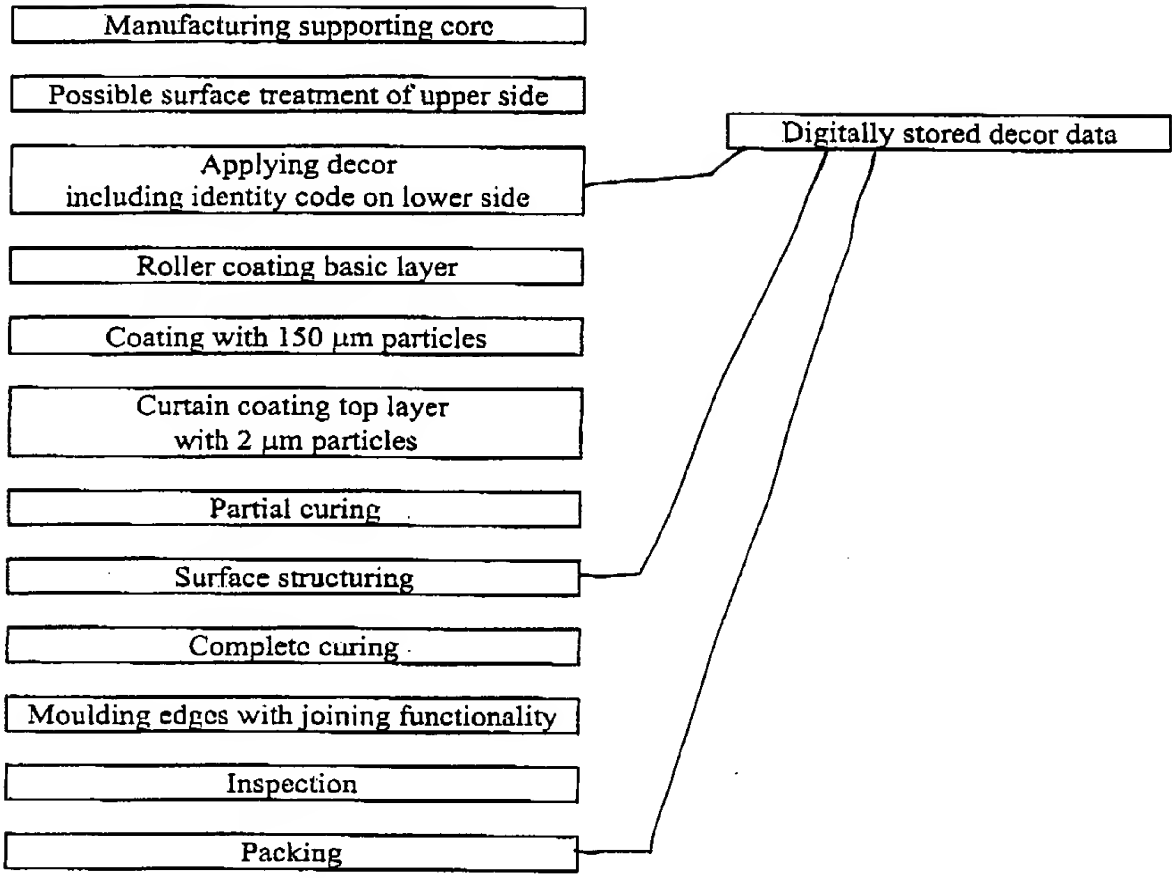
coating. Both layer of lacquer are then cured partially with UV light so that the viscosity increases. A top layer of UV curing lacquer with an additive in the form of hard particles with an average particle size of 2μm is then applied by means of a roller. Hard particles with an average particle size in the range 100nm is sprinkled on top of the still wet top layer whereby the layers are cured with UV light so that the viscosity increases. The still soft lacquer can thereby be provided with a surface structure which is intended to increase the realism in the decor. This is achieved by alternately pressing two structured rollers toward the surface while it passes. The rollers are provided with each one structured matrix, the matrixes having diverging orientation. The orientation of the structures hereby corresponds to the decor. The positioning of the rollers are guided via the digitally stored data which is used for applying the decor itself and the fixing point used there.

One or more matrixes can alternatively form the structured surface of one or more static moulds which momentary is pressed towards the decorative side.

Especially characteristic decor segments such as borderlines between slabs, staves, blocks or the like and also knots, cracks, flaws and grain which is visually simulated in the decor, is suitably stored as digital data. Said data is then suitably used for providing the surface of the lacquer with a structure that matches said characteristic decor segments via an engraving tool or a press mould of a robot and that the engraving tool or pressing tool of said robot is synchronised via by the predetermined fixing point on the supporting core.

The lacquer is then completely cured by means of UV light to the desired strength whereby the finished surface elements may be inspected manually or via computer supported camera. The surface elements are then packed in batches and provided with identification markings. The above process allows a customer guided manufacturing even in very small quantities without any significant set up times and with the same production efficiency as for bulk manufacturing.

Process scheme 2



A wood fibre based supporting core is manufactured and provided with a top side, which is levelled by a slight sanding, and a lower side. The upper side of the supporting core is hereafter provided with a decor which is applied by means of an ink-jet printer. The decor is oriented after a predetermined fixing point in the form of a corner on the supporting core. The basis for the decor is stored as digital data. A basic layer of UV curing acrylic lacquer is applied by means of a roller. Particles with an average particle size in the range 150µm is then sprinkled on the still wet basic layer, whereupon the main layer of UV curing lacquer with a content of hard particles with an average particle size of 2µm is applied through curtain coating. Both layer of lacquer are then partly cured with UV light so that the viscosity of the lacquer increases. The still soft lacquer is then provided with a surface structure intended to increase the realism in the decor. This is achieved by alternately pressing two structured rollers toward the surface while it passes. The rollers are provided with each one structured matrix, the matrixes having diverging orientation. The

orientation of the structures hereby corresponds to the decor. The positioning of the rollers are guided via the digitally stored data which is used for applying the decor itself and the fixing point used there.

The lacquer is then completely cured with UV light to desired strength, whereby the finished surface element is cut to the desired user format and provided with joining means in the edges through milling. The finished surface elements may then be inspected manually or by means of a computer supported camera. The surface elements can then be packed and provided with identification documents. The above process allows a customer guided manufacturing even in very small quantities without any significant set up times and with the same production efficiency as for bulk manufacturing.

The invention is not limited to the shown embodiments since these can be varied in different ways within the scope of the invention. It is for example possible to replace the acrylic ~~lacquer, forming the wear layer in the processes illustrated schematically,~~ with so-called overlay sheets of α-cellulose according to the present invention. These sheets of α-cellulose, which are impregnated with melamine formaldehyde resin is joined with the supporting core by means of heat and pressure whereby the resin cures. The wear resistance can, also in this embodiment, be improved by including hard particles with an average size in the range 50nm - 150μm in the wear layer.

CLAIMS

1. A process for the manufacturing of surface elements (1) which comprises an upper decorative layer (2) and a supporting core (5), c h a r a c t e r i s e d in that;
   i) A supporting core (5) with a desired user format is manufactured and provided with an upper side (1') and a lower side (4), whereby
   ii) the upper side (1') of the supporting core (5) is provided with a decor by, for example, printing, which decor is oriented after a predetermined fixing point on the supporting core (5), whereby
   iii) the upper side (1') of the supporting core (5) is provided with a protecting, at least partially translucent, wear layer (2") by for example curtain coating, spray coating, immersion coating, roller coating or by being provided with one or more sheets of thermosetting resin impregnated α-cellulose.

2. A process according to claim 1, c h a r a c t e r i s e d in that the decor (2') is achieved through digitisation of an actual archetype or by completely or partly being created in a digital media, which digitised decor (2') is stored in digital form in order to be used as guiding means and basic data together with possible control programs when printing the decor (2').

3. A process according to claim 2, c h a r a c t e r i s e d in that at least parts of the digitised decor (2') in addition to support programs is used for guiding further steps in that process such as identification marking, packing, lacquering, storing and delivery logistics, surface structuring and the like.

4. A process according to any of the claims 1 - 3, c h a r a c t e r i s e d in that the supporting core (5) is manufactured in the desired user format, and provided with edges (3) intended for joining, before the decor and wear layer is applied.

5. A process according to any of the claims 1 - 4, c h a r a c t e r i s e d in that the supporting core (5) mainly is constituted by a particle board or a fibre board.

6. A process according to any of the claims 1 - 4, c h a r a c t e r i s e d in that the supporting core (5), at least partly, is constituted by a polymer such as polyurethane or a polyolefin such as polyethylene, polypropylene or polybutene.

7. A process according to claim 6, characterised in that the supporting core (5) in addition to polymers also comprises a particle or fibre formed filler of organic or inorganic material.

8. A process according to any of the claims 1 - 7, c h a r a c t e r i s e d in that the translucent wear layer (2") is constituted by a UV or electron beam curing lacquer, such as for example acrylic, epoxy or maleimide lacquer.

9. A process according to claim 8, c h a r a c t e r i s e d in that the wear layer is applied in several steps with intermediate curing, of which curing the last is a complete curing while the previous curing are partial.

10. A process according to claim 8 or 9, c h a r a c t e r i s e d in that the wear layer also comprises hard particles with an average particle size in the range 50nm - 150µm.

11. A process according to claim 10, c h a r a c t e r i s e d in that the upper surface of the wear layer (2") is provided with hard particles in the range 50nm - 30µm, preferably 50nm - 10µm while the interior of the wear layer (2") comprises particles in the range 10µm - 150µm, preferably 30µm - 150µm.

12. A process according to claim 10, c h a r a c t e r i s e d in that the hard particles consists of silicon carbide, silicon oxide, α-aluminium oxide or the like.

13. A process according to claim 11, c h a r a c t e r i s e d in that the hard particles consists of silicon carbide, silicon oxide, α-aluminium oxide, diamond or the like.

14. A process according to any of the claims 1 - 7, c h a r a c t e r i s e d in that the translucent wear layer (2") is constituted by one or more sheets of α-cellulose which are impregnated with melamine formaldehyde resin.

15. A process according to claim 14, c h a r a c t e r i s e d in that the wear layer (2") is joined with the supporting core (5) through heat and pressure whereby the resin cures.

16. A process according to the claims 14 or 15, c h a r a c t e r i s e d in that the wear layer also comprises hard particles with an average particle size in that range 50nm - 150µm.

17. A process according to claim 16, c h a r a c t e r i s e d in that the upper surface of the wear layer (2") is provided with hard particles with an average particle size in the range 50 nm -30µm, preferably 50 nm - 10 µm while the interior of the wear layer (2") comprises particles in the range 10µm - 150µm, preferably 30µm - 150µm.

18. A process according to claim 16 characterised in that the hard particles is constituted by silicon carbide, silicon oxide, α-aluminium oxide or the like.

19. A process according to claim 17, c h a r a c t e r i s e d in that the hard particles is constituted by silicon carbide, silicon oxide, α-aluminium oxide, diamond or the like.

20. A process according to any of the claims 1 - 19, c h a r a c t e r i s e d in that the decor on the surface elements (1) is constituted by a number of decor sections with intermediate borders, which borders, on at least two opposite edges, coincides with intended adjacent surface element (1).

21. A process according to any of the claims 1 - 20, c h a r a c t e r i s e d in that at least one surface structured matrix which forms at least one surface structure section, is positioned towards the decor side of the floor element (1) in connection to the surface element (1) being provided with a wear layer (2"), and is pressed towards this whereby the wear layer (2") receives a surface with a surface structure (2"') which enhances the realism of the decor.

22. A process according to any of the claims 1 - 21, c h a r a c t e r i s e d in that two or more surface structured matrixes which each forms a surface structure section, which sections are independent of each other in a structure point of view, and that said surface structure sections are intended to, at least partly, but preferably completely coincide with corresponding surface structure sections in the decor (2'), is accurately positioned on the decor side of the floor element (1) in connection to being provided with a wear layer (2") and pressed towards this whereby the wear layer (2") receives a surface with a surface structure (2"') whose orientation corresponds to the orientation of the decor in the different decor sections.

23. A process according to claim 21 or 22, c h a r a c t e r i s e d in that one or more matrixes forms the structured surface of one or more rollers, with counter stay whereby the surface element (1) is passed between the roller and the counter stays with the decor side facing the rollers under continuous or discontinuous pressure between the rollers and the counter stays.

24. A process according to claim 23, c h a r a c t e r i s e d in that rollers containing two or more matrixes have a circumference adapted to the repetition frequency of the variation of orientation in the decor.

25. A process according to claim 22, c h a r a c t e r i s e d in that one or more matrixes forms the structured surface of one or more press belts, with counter stays whereby the surface element (1) is passed between the press belts and the counter stays with the decor side facing the press belts under continuous or discontinuous pressure between the press belts and counter stays..

26. A process according to claim 22, c h a r a c t e r i s e d in that one or more matrixes forms the structured surface of one or more static press moulds which are momentary and statically pressed towards the decor side of the surface element (1).

27. A process according to any of the claims 21 - 26, c h a r a c t e r i s e d in that particularly characteristic decor sections such as borders between slabs, staves, blocks or the like and also knots, cracks, flaws and grain which is visually simulated in the decor (2'), is stored as data, that said data is used for providing the surface of the surface element (1) in said characteristic decor portions with a suitable surface structure via engraving or pressing tools of a robot, and that said engraving tool or pressing tool is synchronised via the predetermined fixing point on the surface element (1).

28. Surface element (1) manufactured according to any of the claims 1 - 27, c h a r a c t e r i s e d in that they form floor elements intended to be joined into a floor covering, wall elements intended to be joined into a wall covering or ceiling element intended to be joined into a ceiling covering.

ABSTRACTS:

A process for the manufacturing of surface elements (1) which includes an upper decorative layer (2), edges (3) intended for joining, a lower side (4) and a supporting core (5). A supporting core (5) is manufactured in the desired format and is thereafter provided with an upper side (1') and a lower side (4). The upper side (1') of the supporting core (5) is thereafter provided with a decor (2') by so called printing. The decor (2') is oriented after a predetermined fixing point on the supporting core (5). The upper side (1') of the supporting core (5) is then provided with a protecting, at least partially transparent wear layer (2") by, for example, curtain coating, spray coating, immersion coating, roller coating or by being provided with one or more sheets of thermosetting resin impregnated α-cellulose.